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BRITISH BROADCASTING CORPORATION

Engineering Division

VISIT TO TELEFUNKEN G.m.b.H. HANOVER, 5th APRIL, 1962

Report No. A-067

(1962/12)

ERRATUM

British Broadcasting Corporation - Engineering Division

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Delete first sentence of Section 8 "COMPATIBILITY OF NTSC" and substitute the following:

Demonstrations previously seen at the Telefunken laboratories by a P.O./B.B.C. party, had shown no apparent beat-frequency pattern produced by the sound carrier and the colour subcarrier.

ENGINEERING DIVISION

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GENERAL

Our visit to Hanover fell naturally into two parts: the first concerned with certain changes in and variance of the NTSC system to reduce its sensitivity to phase errors both of the linear and differential types, while the second was concerned with the compatibility of colour systems of any type although having particular reference to the NTSC system when employing the 625-line C.C.I.R. West European system.

1. COLOUR TELEVISION

The following major items were demonstrated:-

(1) NTSC system with alternating colour phase. This system was demonstrated with three possible means of alternating the phase of the colour information.

(2) A hybrid system employing elements of NTSC and SECAM systems.

(3) SECAM system.

(4) 14 inch and 17 inch Japanese colour display tubes.

(5) A number of interesting test signal arrangements.

2. NTSC SYSTEM WITH ALTERNATING COLOUR PHASE

This is the system which was mentioned by D.D.E. in his report of his recent visit to Germany and to examine which constituted the main reason for our visit to Hanover.

The alternating colour phase system was of the same type as that described by Loughlin in the Proc.I.R.E. of October 1951, to which he gave the name of "oscillating colour sequence" (perhaps in the light of developments, "alternating colour phase" is the better description). In this system the phase of one of the two colour components which are used to modulate the colour sub-carrier is reversed by 180 degrees at every other field. This requires a switch operating at 25 c/s in the coder, and a similar synchronized switch in the colour receiver. The switches are, of course, in general diodes and there is no particular difficulty in their design. The extra cost in a colour receiver would be quite small.

When the alternating colour phase is applied to the system, it can be shown that in conditions of linear transmission and perfect eye memory over two fields, accurate compensation for both phase and differential phase errors would be obtained. In practice, a non-linear system is used in the receiving display tube and, as is well known, the eye has far from perfect memory between the two fields of a 50 c/s field system. In the demonstration given in Hanover, very large differential and phase distortions of the order of ± 30° were used. On pictures derived from transparencies no imperfections in the process of cancellation could be detected, but when colour bars were used with these large distortions, certain of the colours showed a degree of brightness flicker. The same degree of distortion on the NTSC system without a.c.p. was quite intolerable.

The lack of sensitivity to phase errors removes the necessity for fitting a hue control to the NTSC system receiver should it be desired to do so. Setting the hue control over an estimated ± 10° resulted in neither hue distortions nor any trace of brightness flicker, even when using colour bars. The compatibility of the signal with alternating colour phase appeared to be as good as that of the ordinary NTSC signal, although the application of this technique must undoubtedly alter some aspects of the compatibility; this must be a matter for investigation, although it should be emphasized that Herr Bruch himself confirmed that compatibility was subjectively the same with or without alternating colour phase.

We were also shown a system in which the phase of one of the colour components was reversed every other line instead of, as above, every other field. This system gave equally good cancellation of phase errors, but the compatibility was less good since it imparted to the monochrome picture, on certain colours, an apparent line structure of half the normal number.

A third variation of the system was also demonstrated which appeared to be quite effective in cancelling phase errors whilst retaining better compatibility, but the means whereby this was done was not disclosed.

In assessing the results described above, it must be remembered that the colour display tube was the R.C.A. Type 21CYP22 which employs phosphors which have relatively long decay times and which moreover give a picture of restricted brightness. The newer type tubes with their short decay phosphors and brighter pictures would undoubtedly reveal the onset of flicker at smaller amounts of differential and linear phase distortions. However, as we emphasized to Herr Bruch, it is not considered at all likely in this country that we would have to cope with distortions of the order of ± 30°. If the alternating colour phase enabled the present tolerance to be doubled, this would be a very great advantage.

3. HYBRID NTSC-SECAM SYSTEM

This system utilized the SECAM principle of successive transmission of the two pieces of chrominance information on a single colour sub-carrier whilst utilizing certain of the modulation processes of the NTSC system in preference to the f.m. modulation of the present SECAM proposals.

The coder consists of the usual SECAM arrangement incorporating a delay line having one scanning line time delay together with the half line speed switch for sending the two colour components in succession. The modulation of these signals on the sub-carrier follows the usual NTSC practice of amplitude modulation with suppressed carrier. Naturally a burst frequency must be sent so that a carrier can be regenerated at the receiver.

At the receiver, a local carrier is generated by reference to the burst and is added to the chrominance signal, thus producing a normal type of amplitude modulated wave with any reasonable desired depth of modulation. This wave is detected in a straightforward envelope detector, the spurious d.c. which appears on the output of this detector is removed by a.c. coupling, and the proper d.c. component of the colour difference signals is restored near the grid of the display tube by means of clamping. This system has the following advantages over the SECAM system itself:-

(1) Compatibility is better, since no chrominance signal is sent when there is no colour information as in the NTSC. A strict relationship between the line scanning frequency and the colour sub-carrier can be obtained and the interference pattern is therefore "dot-interlaced" as in the NTSC system. However, due to the use of alternate line transmission, the frequency relationships are such that for some colours the half-line relationship is replaced by a whole-line relationship. This makes compatibility of this compromise system, according to Herr Bruch, lie somewhere between that of the NTSC system and of the SECAM system.

(2) A wider band chrominance signal can be transmitted; in fact with this system there is no fundamental reason why both the colour difference signals should not have a bandwidth the same as that of the I signal of the NTSC system. It must be remembered, however, that the delay lines necessary for this system may well restrict the bandwidth very appreciably in practice.

The proposed compromise system has advantages over the NTSC system as follows:-

(1) The phase of the local sub-carrier which must be regenerated for detection of the chrominance signal requires low accuracy as compared with the NTSC. For example, an accuracy of ± 20° results only in a change of amplitude of the chrominance signals of the order of $\frac{1}{2}$ dB. Thus, the local synchronized oscillator can be of relatively crude design, but on the other hand our experience has shown that the difficulty in the design of these oscillators lies as much in avoiding locking to a side band of the colour burst signal as in achieving precise phase stability. The compromise system would require avoidance of the locking to a side band just as much as does the NTSC.

(2) Linear and differential errors produced only minor changes in saturation. The system would undoubtedly be easier for magnetic recording purposes.

This compromise system has a disadvantage as it employs both a delay line and a local oscillator, and is in this respect inferior to both SECAM and NTSC which individually only employ one of these devices. Moreover, it is doubtful whether the local oscillator of the compromise system would be any simpler or cheaper than that required for NTSC proper; particularly this might be true if NTSC employed alternating colour phase.

4. SECAM SYSTEM

Not much need be said about the SECAM system, since, although it was demonstrated to us, Herr Bruch suggested that it was not working at its best and we therefore gave it little attention. In discussions, however, it should be said that Herr Bruch emphasized that it is his view up to the present time that the SECAM system is considerably inferior in compatibility. This only confirms the views of many observers who have seen the system from time to time.

5. JAPANESE DISPLAY TUBES

We were shown R.G.B. pictures on two Japanese colour tubes, one a 14 inch tube and the other a 17 inch. Both of these tubes produced extremely vivid and attractive colour bars and appeared to have phosphors which were nearer to the spectrum locus than those of the latest R.C.A. and Mullard tubes using the sulphide phosphors. This, however, may have been an optical illusion due to the high brightness and wide contrast range of the pictures which certainly put into the shade those of the other colour displays. We formed the very distinct impression that a receiver based on the 17 inch size rectangular tube would be a most attractive proposition for the British market when a colour television service commences.

6. TEST SIGNALS

There was available a number of interesting test signals which are worth considering for adoption. One of these is the rather obvious arrangement of having a split-screen facility so that on a single colour display, two colour pictures from different sources can be shown side by side, the one say in the top half and the other in the bottom half, or alternatively one in the right-hand side and the other in the left-hand side. This is a particularly advantageous arrangement to assess two colour signals which are nominally the same.

The second test signal of interest consisted of horizontal colour bars. The advantage of this arrangement as opposed to vertical colour bars is that the transitions between the colour bars are substantially perfect since these are determined by the scanning process and not by the chrominance signal which, as is well known, introduces aberations between certain hue and saturation changes.

7. COLOUR PICTURE QUALITY

Herr Bruch apologized on several occasions for the inadequate quality of some of the arrangements. On the other hand, we thought that he had in a very small laboratory an extremely large range of technical equipment and facilities, most of which was working extremely well. In so far as the phenomena which we went to see displayed were concerned, the facilities were absolutely first-class and there was no doubt at all that we were shown all the work that was going on in the laboratory at the present time. On the other hand, it must be said that the quality of the colour pictures displayed to us on the 21 inch R.C.A. tubes in the various receivers in which they were fitted was uniformly rather poor. The only colour picture which approached the quality of those to which we are accustomed here were those seen on the Japanese tubes, and it must be remembered that these were in R.G.B. form.

8. COMPATIBILITY OF NTSC

Demonstrations previously seen at the Telefunken laboratories by a P.O./B.B.C. party, had shown no apparent beat-frequency pattern produced by the sound carrier and the colour subcarrier. This was surprising because tests carried out at the B.B.C. both by Research Department and Designs Department, had shown this to be a serious problem if receivers employed intercarrier sound, and had only 26 dB of attenuation at the sound carrier frequency relative to that at the main sideband frequencies.

The reception of NTSC colour emission by a domestic monochrome receiver was demonstrated to us by Herr Bruch. We were told that the sound carrier was 7 dB less than the peak vision carrier and the peak deviation of the sound signal (orchestral music) was 50 kc/s. The receiver had a.f.c. and was described as having an overall response curve which was down by 2 dB at subcarrier frequency and 26 dB at the sound carrier frequency. No beat-frequency pattern was visible. The signal level at the receiver input was said to be about 3 mV.

It was noticed that the receiver display did not have the resolution which we would expect from the claimed amplitude/frequency response. By means of adjusting the display brightness when a test pattern was being received we estimated that the displayed picture was attenuated by some 6 dB at 4 Mc/s and by at least 20 dB at 5 Mc/s. From this we deduced that the subcarrier (4·43 Mc/s) was between 6 and 10 dB down.

Examination of the circuit diagram showed that the receiver had a 20 dB attenuation at the sound carrier frequency before the first i.f. valve. Both these facts were not sufficient to explain the difference between B.B.C. tests and these at Telefunken.

When we explained to Herr Bruch how seriously we were perturbed by this disagreement he very generously permitted us to examine the experimental layout in detail. We found a point of disagreement in the method of setting up the relative amplitudes of the sound and vision carriers. It turned out that, in the experiment demonstrated, the ratio of vision and sound carrier amplitudes was in excess of 20 dB. When an agreed procedure had been followed, the interference pattern on the received picture agreed very well with what B.B.C. tests* had led us to expect. In fact, in view of the receiver design and of the observed receiver resolution, the beat pattern appeared somewhat more serious than we expected.

It was observed that, subsequent to the readjustment of the sound carrier amplitude, the sound/subcarrier beat pattern had become slightly visible on an R.C.A. colour receiver which should have had adequate filtering at the sound and subcarrier frequencies. We thought that the most probable cause of this trouble was cross modulation occurring either in the modulator or the following power amplifier. The carrier was modulated with a waveform which combined vision plus f.m. modulated sound carrier. Later that evening, however, Herr Bruch said that it was possible that the sound notch filter had been removed from the colour receiver.

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* "The Effect of the Sound Modulation System upon the Monochrome Reception of NTSC - Type Colour Television Signals", Research Department Report No. T-087, Serial No. 1962/3.

Even when allowance was made for the possibility of the modulator or the amplifier producing some of the beat-pattern interference it was quite evident that the Telefunken receivers at present being produced will exhibit the beat pattern when colour transmissions commence if the transmitted sound-carrier amplitude is only 7 dB less than that of the vision carrier.

The demonstration was repeated with a receiver not fitted with a.f.c. and the results were similar to those using the receiver fitted with a.f.c. except that it was possible to detune the receiver and remove the interference at the expense of picture quality. Tuning this receiver to a monochrome emission by observation of the sound quality permitted a wide range of tuning over much of which the picture quality was poor. The receiver, tuned to a monochrome emission, could be left in a condition likely to produce serious impairment of picture quality if a colour subcarrier was added.

9. MONOCHROME RECEPTION IN HANOVER AND AMSTERDAM

We did not have many opportunities to observe the reception of monochrome television but we did very briefly see reception in the home of Herr Bruch. Reception from the local (Hanover) u.h.f. station was very good except for one distinct echo which Herr Bruch explained could be removed by rotating his aerial. At the time we were there, the aerial had been adjusted to obtain a compromise performance from several transmitters. The v.h.f. reception appeared rather poor as regards pattern interference, noise and impulsive interference.

On our return trip we saw a television receiver in a café in Amsterdam. The picture was marred by impulsive interference in the form of defocused white spots. Closer inspection showed that each white spot was preceded by a small black spot. The receiver was reasonably focused in the greys but tended to "crush" whites and to defocus a little. The extent of this was by no means exceptional by British domestic viewing standards.

The white interference spots appeared to be caused by the overshoot of the transient response of the i.f. or video amplifier caused possibly by excursions into grid current in one of the stages. This interference was much more visible than is normally the case in Britain with modern receivers fitted with diode limiters. From this single example it would appear that it may be necessary to fit a peak-white limiter for suppressing the overshoot for areas likely to suffer from impulsive interference.

One other point of interest to us was that almost all the television receiving aerials in rural Holland were mounted on metal poles some 25 feet high above the rooves of dwelling houses. They were guyed to the corners of the rooves and provided an aerial height estimated as between 50 and 60 feet.

10. CONCLUSIONS

1. Herr Bruch has rendered a service in calling attention again to the virtues of the system of colour phase alternation invented some eleven years ago. It is suggested that Designs Department should as rapidly as possible incorporate alternating colour phase modifications in a 625-line system so that its advantages and disadvantages can be more closely assessed.

2. The compromise colour system suggested by Herr Bruch using SECAM sequential transmission and NTSC suppressed carrier modulation, should be carefully considered and it may be thought worth while in due course to set up experimental equipment to explore its possibilities.

3. The B.B.C. should buy some of the 17 inch Japanese tubes as soon as possible.

4. The observations of the compatibility of a NTSC 625-line system made on typical German receivers at the Telefunken laboratories confirmed the results which have been obtained in our own laboratories in this country. It is confirmed that the combined attenuation of the colour sub-carrier and sound carrier with respect to the maximum response of the receiver must be about 40 dB (this assumes that the C.C.I.R. vision-to-sound transmitter power ratio will be maintained. An alternative approach might be to increase this ratio by, say, 4:1 and reduce the required combined loss in the receiver to 34 dB). In our view, this point is of such vital importance to the future success of a colour system that it should once again be brought to the attention of B.R.E.M.A.

BRH